msystems mssd

FFD 2.5" Serial ATA Flash Disk

Product Specification and User Manual

November 2006

42-PS-0605-00 Rev. 1.2

DOCUMENT CONTROL INFORMATION

DCO No.:

	Title	Name	Date
Issued by:	Rugged Product Manager, Embedded Division	Guy Freikorn	March 2006
Approved by:	VP Sales and Marketing, Embedded Division	Ofer Tzur	March 2006

REVISION HISTORY

Revision	Date	Description	Reference
1.1	March 13, 2006	Updated memory density table	Section 3.3.6
		Updated physical characteristics	Section 3.3.10
		Updated Reliability (MTBF) table	Section 3.4
		Updated Security Erase Functionality tables	Section 4.4.2
		Updated ordering information table	Section 12
1.2	November 29, 2006	Updated Power consumption table	Table 3
		Updated Power consumption during Security Erase table	Table 19
		Updated Security Erase time and mount time tables	Section 4.4.2
		Updated mount time table	Table 24

TABLE OF CONTENTS

1. Scope 5
2. Applicable Documents 5
3. Specifications 6
3.1. Product Definition 6
3.2. Interface Description 6
3.3. Characteristics 7
3.3.1. SATA Modes 7
3.3.2. Burst Read/Write Performance 7
3.3.3. Sustained Read/Write Performance 7
3.3.4. Access Time 7
3.3.5. Seek Time 7
3.3.6. Memory Density 7
3.3.7. Power Consumption 9
3.3.8. Endurance 10
3.3.9. Physical Characteristics 11
3.3.10. LED Indicator 12
3.3.11. Connector Interface 12
3.4. Reliability - Mean Time Between Failures (MTBF) 13
3.5. Error Detection/Correction Code (EDC/ECC) 14
3.6. Environmental Conditions 14
3.6.1. Temperature 14
3.6.2. Altitude 14
3.6.3. Relative Humidity 14
3.6.4. Shock 14
3.6.5. Vibration 15
4. FFD 2.5" Serial ATA Drive Configuration 16
4.1. Optional Jumper Setting 16
4.1.1. Reserved Jumper 16
4.1.2. Write-Protect Jumper Settings 16
4.1.3. Secure Erase Jumper 16
4.2. Interface Connectors 16
4.3. Supported ATA Commands 17
4.4. Vendor-Specific Commands 18
4.4.1. Sanitize 18
4.4.2. Security Erase Functionality 26
4.4.3. Configuration 28

4.4.4. Sanitizing Partitions 30
4.4.5. S.M.A.R.T Command 31
4.4.6. Format Unit Command 32
5. Firmware Upgrade 33
6. Mount Time 34
7. Compatibility 35
8. Label Information 36
9. Built-In Test (BIT) 37
10. Installing and Using the FFD 2.5” Serial ATA 38
10.1. Kit Contents 38
10.2. Visual Inspection 38
10.3. Handling Instructions 38
10.4. Installation 39
10.4.1. System Requirements 39
10.4.2. FFD Configuration 39
10.4.3. Installation 39
11. Troubleshooting 41
11.1. The FFD Is Not Identified by the System BIOS 41
11.1.1. Basic Checks 41
11.1.2. BIOS Setup 41
11.2. Disk Performance Is Slow 41
11.3. The FFD Functions as an Additional Drive but Fails to Boot 41
11.4. Linux Installation Is Complete but the System Does Not Boot 41
12. Ordering Information 42
How to Contact Us 43

1. SCOPE

This specification and user manual defines the performance, design and acceptance requirements for the FFD 2.5” Serial ATA flash disk. It also provides instructions for proper installation and use.

Throughout this manual, the FFD 2.5” Serial ATA flash disk will be referred to as FFD.

2. APPLICABLE DOCUMENTS

- Serial ATA: High-speed serialized AT attachment, revision 1.0a, Serial ATA working group
- SFF documents
- EIA-720 document

3. SPECIFICATIONS

3.1. Product Definition

The FFD 2.5” Serial ATA (SATA) is a non-volatile mass memory storage unit equipped with a SATA interface. The FFD, whose dimensions enable mounting in a standard 2.5” disk drive enclosure, contains the following components:

- CPU
- 2.5” SATA connector
- SATA controller
- Flash memory

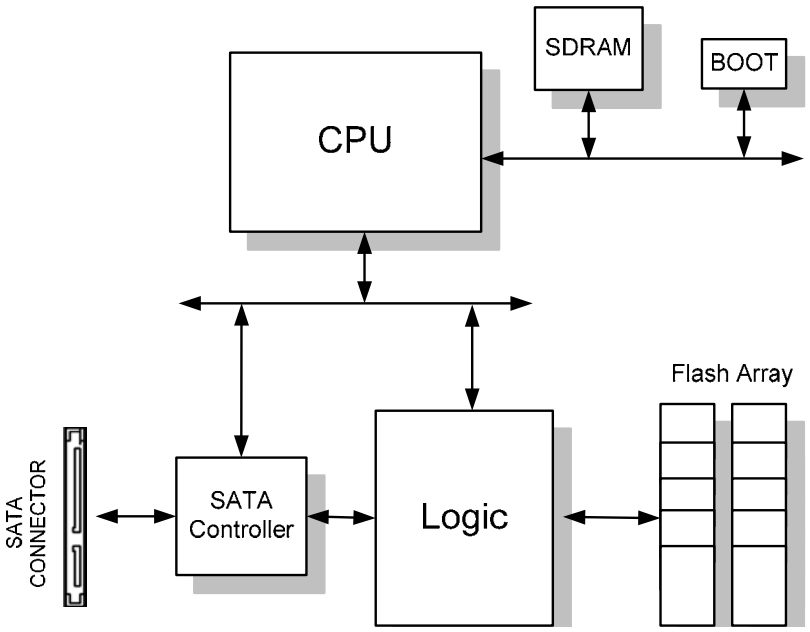


Figure 1: FFD 2.5” Serial ATA Block Diagram

3.2. Interface Description

The FFD’s SATA interface complies with the SATA 1.0a standard. For specific details, refer to the applicable documents, as specified in Section 2.

3.3. Characteristics

3.3.1. SATA Modes

The FFD supports the following ATA modes:

- PIO mode 0, 1, 2, 3, 4
- DMA mode 0, 1, 2
- Ultra DMA mode 0, 1, 2, 3, 4, 5

3.3.2. Burst Read/Write Performance

The FFD burst read/write rate is 150 MB/sec (1.5 Gb/sec).

3.3.3. Sustained Read/Write Performance

The FFD meets the performance requirements specified in Table 1. Performance was measured on a computer using the following setup:

- Density: 12GB
- Configuration: Ultra DMA Mode 5, with 128K blocks aligned on 128K boundaries
- Platform: ASUS P4T533-C with Intel 2.4 GHz
- Testing utilities:
  - H2Bench (DOS)
  - H2benchW (Windows XP)

Table 1: FFD 2.5" Serial ATA Ultra DMA Mode 5 Transfer Rates

Operation	Burst Rate (MB/sec)	Sustained Rate 128KB Blocks (MB/sec)
Read	150	44
Write	150	40

3.3.4. Access Time

Maximum access time for the FFD is < 0.04 msec.

3.3.5. Seek Time

The FFD has no seek time.

3.3.6. Memory Density

FFD memory density information is described in Table 2.

Table 2: FFD 2.5” Serial ATA Densities

Unformatted Disk Density (GB)	**Total Number of User-Addressable Sectors in LBA Mode** (Words 60/61 of IDENTIFY information)	**Number of Logical Sectors per Track** (Words 6 and 56 after power-on of IDENTIFY information)	**Number of Logical Heads** (Words 3 and 55 after power-on of IDENTIFY information)	**Number of Logical Cylinders** (Words 1 and 54 after power-on) of IDENTIFY information)	**Current CHS Density (Sectors)** (Words 57/58 after power-on of IDENTIFY information)
1	1982464	63	16	1966	1981728
2	3995648	63	16	3963	3994704
4	7991296	63	16	7927	7991296
8	16044032	63	16	15916	16044032
12	24096768	63	16	16383	16514064
16	32149504	63	16	16383	16514064
24	48254976	63	16	16383	16514064
32	64360448	63	16	16383	16514064
40	80465920	63	16	16383	16514064
48	96571392	63	16	16383	16514064
56	112680960	63	16	16383	16514064
64	128786432	63	16	16383	16514064
72	144891904	63	16	16383	16514064
80	160997376	63	16	16383	16514064
88	177102848	63	16	16383	16514064
96	193208320	63	16	16383	16514064
104	209317888	63	16	16383	16514064
112	225423360	63	16	16383	16514064
120	241528832	63	16	16383	16514064
128	257634304	63	16	16383	16514064

Note: The information in this section is relevant for FFD units with firmware version 1.03 and later.

3.3.7. Power Consumption

The FFD requires input voltage of +5VDC, with a tolerance of 5% (4.75V-5.25V) and a maximum ripple of 250 mV peak-to-peak. Table 3 describes the power consumption based on density. The power consumptions depend on the disk density and the flash components being used.

Table 3: FFD 2.5" Serial ATA Typical Power Consumption

Unformatted Disk Density	Idle Mode		Read/Write Mode	
GB	mA	W	mA	W
1 – 16	390	1.95	430	2.15
128	490	2.45	590	2.95

Note: The information in this section is relevant for FFD units with firmware version 1.03 and later.

3.3.9. Endurance

The FFD sustains more than 5,000,000 erase cycles and an unlimited number of read cycles. Performance is enhanced by the following features:

- **Dynamic wear-leveling algorithm**: This algorithm guarantees the use of all flash blocks at the same level of stress (write/erase cycle). The dynamic wear-leveling algorithm eliminates situations where repeated writes to the same logical location cause flash block wear-out. The dynamic wear-leveling algorithm functions by mapping logical blocks to physical blocks (transparent to the customer application).
- **Garbage collection process**: The garbage collection process eliminates the need to perform erasure prior to every write, thus eliminating excessive disk deterioration.
- **EDC/ECC (Error Detection Code/Error Correction)**: The EDC/ECC extends disk endurance by detecting and then fixing flash bits.
- **Bad-block mapping algorithm**: This algorithm replaces bad blocks with new ones from available spares.

3.3.10. Physical Characteristics

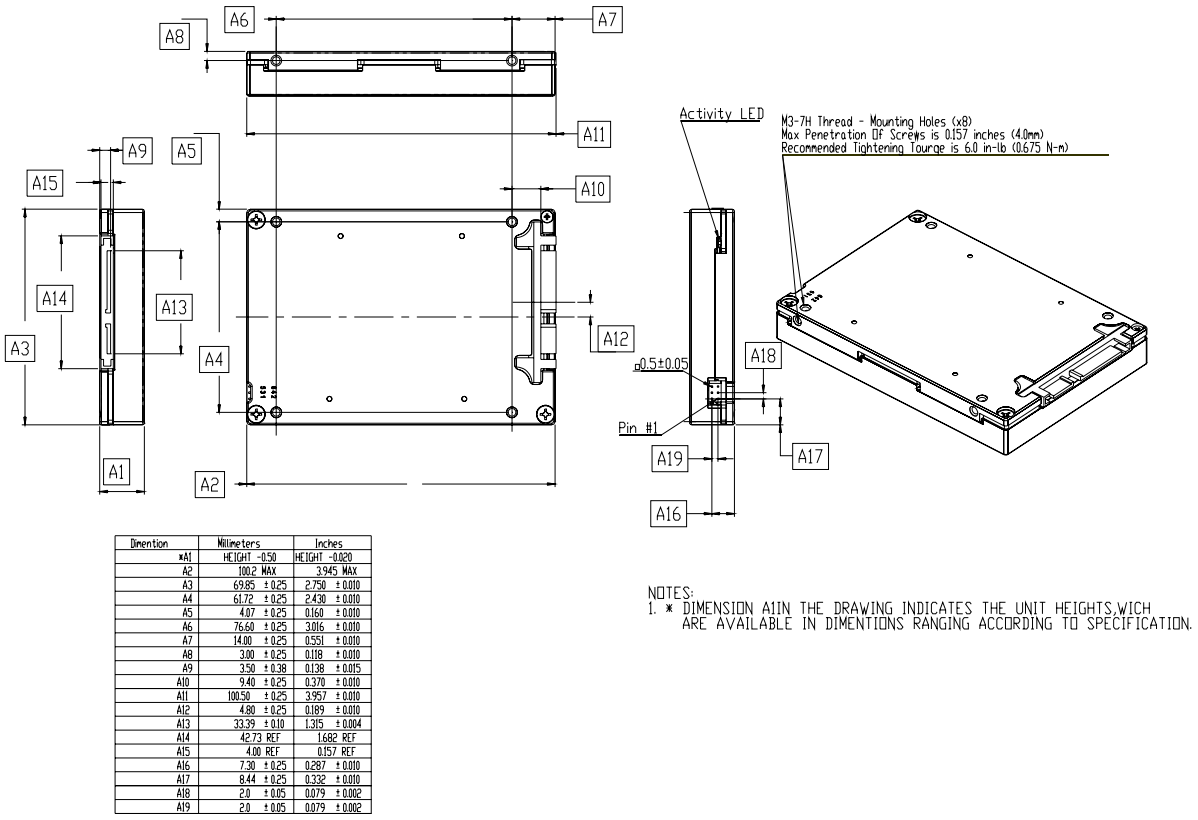
Table 4 describes the nominal dimensions of the FFD, with the maximum weight for each unit case.

Table 4: Nominal Dimensions, Maximum Density and Weight

		Inches	Millimeters	Max. Density	Max. Unit Weight (kg)
H:	A	0.374	9.5	1GB to 8GB, 16GB	0.10
	B	0.571	14.5	12GB, 24GB to 64GB	0.14
	C	0.728	18.5	72GB to 112GB	0.18
	D	0.886	22.5	120GB, 128GB	0.22
W:		2.75	69.85		
L:		3.945	100.2		

For detailed mounting configuration dimensions, refer to Figure 2.

Note: The information in this section is relevant for FFD units with firmware version 1.03 and later.



Dimention	Millimeters	Inches
*A1	HEIGHT -0.50	HEIGHT -0.020
A2	100.2 MAX	3.945 MAX
A3	69.85 ± 0.25	2.750 ± 0.010
A4	61.72 ± 0.25	2.430 ± 0.010
A5	4.07 ± 0.25	0.160 ± 0.010
A6	76.60 ± 0.25	3.016 ± 0.010
A7	14.00 ± 0.25	0.551 ± 0.010
A8	3.00 ± 0.25	0.118 ± 0.010
A9	3.50 ± 0.38	0.138 ± 0.015
A10	9.40 ± 0.25	0.370 ± 0.010
A11	100.50 ± 0.25	3.957 ± 0.010
A12	4.80 ± 0.25	0.189 ± 0.010
A13	33.39 ± 0.10	1.315 ± 0.004
A14	42.73 REF	1.682 REF
A15	4.00 REF	0.157 REF
A16	7.30 ± 0.25	0.287 ± 0.010
A17	8.44 ± 0.25	0.332 ± 0.010
A18	2.0 ± 0.05	0.079 ± 0.002
A19	2.0 ± 0.05	0.079 ± 0.002

Figure 2: FFD 2.5" Serial ATA Assembly

A1 in Figure 2 indicates the case heights, which are available in dimensions ranging from 9.5 mm to 22.5 mm. For available cases heights, please refer to Table 4.

3.3.11. LED Indicator

The FFD includes two LEDs, one green and one red, located on the rear panel. These LEDs indicate the following:

- **Power (green) LED**: This is the FFD power indicator. When the power LED is lit, the FFD is receiving power.
- **Busy (red) LED**: This is the FFD busy indicator:
  - When the busy LED is lit, the FFD is active.
  - When the FFD cable is unplugged, the busy LED blinks every 500 msec.
  - When the busy LED is blinking, the SATA segment cable is disconnected.

3.3.12. Connector Interface

The FFD interface connector pinout is described in Table 5, Table 6, and Figure 3.

Table 5: FFD 2.5" Serial ATA Signal Segment Pin Assignment

Pin #	Signal Name	Description
S1	Ground	2nd mate
S2	A+	Differential signal pair A from Phy
S3	A-	
S4	Ground	2nd mate
S5	B-	Differential signal pair B from Phy
S6	B+	
S7	Ground	2nd mate

Table 6: FFD 2.5" Serial ATA Power Segment Pin Assignment

Pin #	Signal Name	Description
P1	V33	3.3 V power
P2	V33	3.3 V power
P3	V33	3.3 V power, pre-charge, 2nd mate
P4	GND	1st mate
P5	GND	2nd mate
P6	GND	2nd mate
P7	V5	5 V power, pre-charge, 2nd mate
P8	V5	5 V power
P9	V5	5 V power
P10	GND	2nd mate
P11	Reserved	The pin corresponding to P11 in the backplane receptacle connector is also reserved. The pin to be mated with P11 in the power cable receptacle connector must always be grounded.

Pin #	Signal Name	Description
P12	GND	1st mate
P13	V12	12V power, pre-charge, 2nd mate
P14	V12	12V power
P15	V12	12V power

The following points should be noted:

- All pins are in a single row, with a 1.27 mm (.050") pitch.
- The comments on the mating sequence in Table 6 apply for backplane blind-mate connector cases only. In this situation, the mating sequences are: (1) Ground pins P4 and P12; (2) Pre-charge power pins and the other ground pins; and (3) Signal pins and the rest of the power pins.

  There are three power pins for each voltage. One pin from each voltage is used for pre-charge in a backplane blind-mate situation.

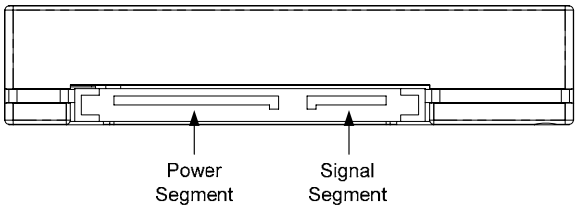


Figure 3: FFD 2.5" Serial ATA Pin Configuration

3.4. Reliability - Mean Time Between Failures (MTBF)

The MTBF statistics for the FFD, described in Table 7, were calculated based on Telcordia SR-332, GB, 25°C.

Table 7: MTBF for the FFD 2.5" Serial ATA

Density	MTBF (Hours)	FIT (Failure Rate per Million Hours)
1GB – 8GB, 16GB	1,180,777	0.8469
32GB	1,000,600	0.9993
48GB	825,150	1.2119
64GB	613,986	1.6287
80GB	561,419	1.7812
128GB	390,167	2.563

A detailed report can be supplied upon request.

Note: The information in this section is relevant for FFD units with firmware version 1.03 and later.

3.5. Error Detection/Correction Code (EDC/ECC)

The FFD has embedded error detection and error correction hardware and software mechanisms. The EDC/ECC uses the BCH algorithm, which can detect up to 5 errors in 512 bytes of data, and correct up to 4 errors.

3.6. Environmental Conditions

The FFD complies with the specified performance requirements after exposure to non-operating environmental conditions, or during and after exposure to operating environmental conditions.

3.6.1. Temperature

3.6.1.1 Operating

The FFD operates without degradation over the following ambient air temperature range (the maximal temperature change rate shall not exceed 5°C per minute):

- Commercial temperature version: 0°C to +70°C
- Enhanced temperature version: -25°C to +75°C
- Extended/Industrial temperature version: -40°C to +85°C

3.6.1.2 Non-Operating

The FFD complies with the specified performance requirements after exposure to the following conditions (the maximal temperature change rate may not exceed 5°C per minute):

- Nominal ambient temperature of -55°C for less than 72 hours
- +95°C for a period of less than 24 hours

3.6.2. Altitude

The FFD is capable of full operation at altitudes from sea level to 80,000 feet above sea level, and can withstand air transportation in non-pressurized flights at altitudes of up to 80,000 feet above sea level.

3.6.3. Relative Humidity

The FFD withstands 5% to 95% non-condensing relative humidity.

3.6.4. Shock

The FFD operates without degradation when subjected to shock testing of 1500 G half-sine pulses of 0.5 ms.

Shock analysis was performed according to standard MIL-STD-810F.

3.6.5. Vibration

The FFD operates without degradation when subjected to the following vibration conditions:

- 16.3 G RMS
- Random vibrations: 3 vibration axes, 10 Hz to 2000 Hz.

Vibration analysis was performed according to standard MIL-STD-810F.

4. FFD 2.5” SERIAL ATA DRIVE CONFIGURATION

4.1. Optional Jumper Setting

The FFD has an optional header located on the back panel that supports the following options:

- Secure Erase
- Write Protect

The Write Protect jumper may not be modified when the unit is powered on.

4.1.1. Reserved Jumper

Positions 1 - 2 of the header are reserved (used for fault output). No jumper or signal should be placed over these positions.

4.1.2. Write-Protect Jumper Settings

When a jumper is placed between positions 3 - 4 of the header, the FFD is write protected.

4.1.3. Secure Erase Jumper

When a jumper is placed between positions 5 - 6 of the header, the FFD erases the media.

Note: The Secure Erase jumper overrides the Write-Protect jumper and erases the media.

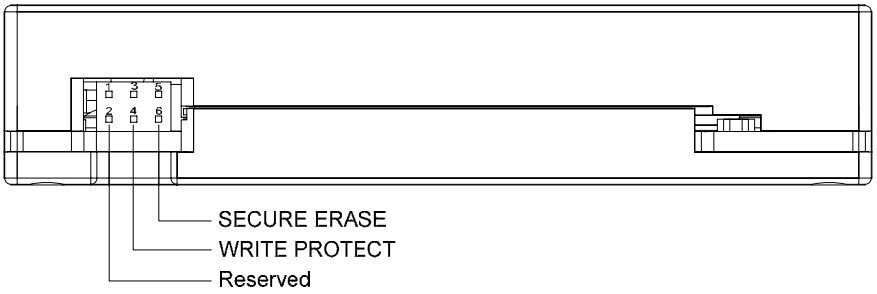


Figure 4: FFD 2.5” Serial ATA Write Protect Jumper Settings

4.2. Interface Connectors

The FFD interface cable consists of four conductors in two differential pairs, plus three ground connections. There are total of 7 pins in the signal segment and 15 pins in the power segment. All pins are in a single row, with a 1.27 mm (0.050”) pitch.

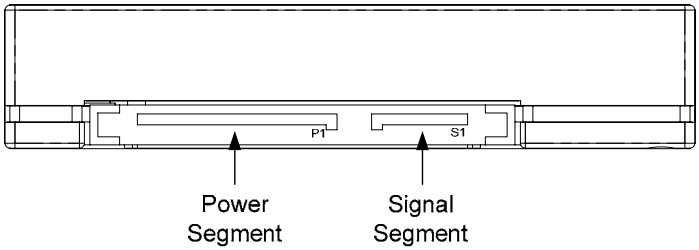


Figure 5: FFD 2.5" Serial ATA Interface Connector

4.3. Supported ATA Commands

The FFD supports the commands listed in Table 8. For a complete description of these commands, refer to the ATA-6 Standard.

Table 8: ATA Commands

Command Name	Command Code (Hex)
CHECK POWER MODE	98h E5h
DOWNLOAD MICROCODE	92h
EXECUTE DEVICE DIAGNOSTIC	90h
FLUSH CACHE	E7h
FORMAT UNIT	F7h
IDENTIFY DEVICE	ECh
IDENTIFY DEVICE DMA	EEh
IDLE	97h E3h
IDLE IMMEDIATE	95h E1h
INITIALIZE DEVICE PARAMETERS	91h
NOP	00h
READ BUFFER	E4h
READ DMA (w/ retry)	C8h
READ DMA (w/o retry)	C9h
READ MULTIPLE	C4h
READ SECTOR(S) (w/ retry)	20h
READ SECTOR(S) (w/o retry)	21h
READ VERIFY SECTOR(S) (w/ retry)	40h
READ VERIFY SECTOR(S) (w/o retry)	41h
RECALIBRATE	10h
SANITIZE (including fast secure erase)	82H
SECURITY DISABLE PASSWORD	F6h
SECURITY ERASE PREPARE	F3h
SECURITY ERASE UNIT	F4h
SECURITY FREEZE	F5h

Command Name	Command Code (Hex)
SECURITY SET PASSWORD	F1h
SECURITY UNLOCK	F2h
SEEK	70h
SET FEATURES	EFh
SET MULTIPLE MODE	C6h
SLEEP	99h E6h
SMART	B0h
STANDBY	96h E2h
STANDBY IMMEDIATE	94h E0h
WRITE BUFFER	E8h
WRITE DMA (w/ retry)	CAh
WRITE DMA (w/o retry)	CBh
WRITE MULTIPLE	C5h
WRITE SECTOR(S) (w/ retry)	30h
WRITE SECTOR(S) (w/o retry)	31h
WRITE VERIFY	3Ch
IRIG-106 READ FAILED SANITIZE BLOCKS LIST	81h
IRIG-106 READ FAILED SANITIZE BLOCKS DATA	83h

4.4. Vendor-Specific Commands

4.4.1. Sanitize

4.4.1.1 Sanitize (Purge) Command Interface

The Sanitize command enables destruction (purging/declassifying) of the information on the media.

Bad blocks accumulated since the unit was manufactured undergo the same process as good blocks. The default sanitize procedure can be activated using either the Sanitize command itself, or using the Sanitize Interrupt command.

The Sanitize command provides a high degree of flexibility, which enables executing declassification procedures defined in various standards by providing different arguments to the command.

Specifically, the Sanitize command parameters enable defining up to three stages of the declassification process. Each stage can be either erasing the media and overwriting it with a given character, or erasing the media and filling it with random information a specified number of times.

If the number of erase-fill cycles is 0, the Sanitize command performs a complete erase but does not fill the media. This is the fastest option; and is also known as the Security Erase option.

The structure of the Security Erase command is described in Table 9.

Table 9: Vendor-Specific Sanitize Command

Register	7	6	5	4	3	2	1	0
Features	Secondary operation code							
Sector count	Master command							
Sector number	Parameter 1							
Cylinder low	Parameter 2							
Cylinder high	Parameter 3							
Device/Head	1		1	D	Partition Mask			
Command	82h							

The Secondary Operation code may be one of the following:

- 0x21 (corresponding to the character '!'): Immediately activates the Sanitize procedure.
- 0x22 (corresponding to the character '"'): Immediately activates the Sanitize procedure with bad-block management according to IRIG-106
- 0x44 (corresponding to character 'D'): Saves the specified parameters as the default Sanitize configuration, but does not activate the Sanitize procedure itself.
- 0x45 (corresponding to character 'E'): Saves the specified parameters as the default Sanitize configuration according to IRIG-106, but does not activate the Sanitize procedure itself.

The default Sanitize procedure is factory-preset to the Security Erase option (erase the media without media fill).

The master command has the following layout:

Bits 6-7: Subcommand selection

Value of 00b: Execute default Sanitize procedure

Value of 01b: Execute 1 subcommand, defined in bits 0-1

Value of 10b: Execute 2 subcommands, defined in bits 0-1 and 2-3

Value of 11b: Execute 3 subcommands, defined in bits 0-1, 2-3 and 4-5

Attempting to save the default Sanitize configuration (option 'D') using subcommand selection 00b will result in an aborted command and no changes will be made.

When the master command specifies only 1 or 2 subcommands, parameters for the remaining subcommands are reserved and should be set to 0 for compatibility with future versions.

For the default Sanitize procedure, all other bits in the master command and parameters1-3 are reserved and should be set to 0 for compatibility with future versions.

Bits 0-1, 2-3 and **4-5** of the master command contain the following subcommands:

Value of 0: Erase and fill with given character. The character is provided in the corresponding parameter.

Value of 1: Erase and fill with random data, several times. The number of erase/fill loops is provided in the corresponding parameter. Zero number of loops means erase once and do not fill. Only the 7 least significant bits in the parameter are used to specify the number of loops. The most significant bit is reserved for future extensions.

Value of 2 or **3**: These subcommands are reserved for future extensions.

Parameter1 corresponds to the subcommand in bits 0-1.

Parameter2 corresponds to the subcommand in bits 2-3.

Parameter3 corresponds to the subcommand in bits 4-5.

Partition Mask is either a bitmap of partitions to be sanitized or value 0. In bitmap mode, least-significant bit 1 corresponds to partition 0. Value of zero is a special value; it corresponds to sanitizing the whole media regardless of partition configuration.

For example, Value of 0xF (or 1111 binary) corresponds to sanitizing of all 4 partitions,

Value of 0x8 (or 1000 binary) corresponds to sanitizing partition number 3,

Value of 0x1 (or 0001 binary) corresponds to sanitizing partition number 0,

Value of 0x5 (or 0101 binary) corresponds to sanitizing partitions 0 and 2,

Value of 0 (or 0000 binary) corresponds to sanitizing the whole media.

See Section 4.4.4 for additional information on sanitizing partitions.

4.4.1.2 Compliance with Existing Sanitize (Purge) Standards

The interface specified in Table 10 enables defining a wide range of Sanitize procedures.

Table 10: Supported Sanitizing Procedures

Operation	Master Command	Parameter		
		1	2	3
Execute the default Sanitize procedure.	0x00	0x00	0x00	0x00
Erase the media (Security Erase).	0x41	0x00	0x00	0x00
USA-AF AFSSI 5020 Erase the media and overwrite with random data.	0x41	0x01	0x00	0x00
USA Navy NAVSO P-5239-26 Erase the media and overwrite with random data, then erase again.	0x85	0x01	0x00	0x00
DoD 5220.22-M Erase the media and overwrite with single character, then erase again.	0x84	Char	0x00	0x00
NSA Manual 130-2 Erase the media and overwrite with random data 2 times, then erase and overwrite with a character.	0x81	0x02	Char	0x00

Operation	Master Command	Parameter		
		1	2	3
USA-Army 380-19 Erase the media and overwrite with random data, erase and overwrite with a character, then erase and overwrite with complement of the character.	0xC1	0x01	Char	~Char
NISPOMSUP Chap 8, Sect. 8-501 Overwrite all locations with a character, its complement, and then random data.	0xD0	Char	~Char	0x01
IREC (IRIG) 106: Erase the media, overwrite with 0x55, erase, overwrite with 0xAA, erase.	0xD0	0x55	0xAA	0x00
Erase the media and overwrite with random data (different data each time) 21 times.	0x41	0x15	0x00	0x00
Erase the media and overwrite with random data (different data each time) 381 times	0xD5	0x7F	0x7F	0x7F

Notes: 1. Before every overwrite process, all blocks are erased as per the flash specification.

2. Blocks subjected to the Sanitize procedure are all blocks not registered in the original manufacturer's Bad Block Table.

4.4.1.3 Sanitize Interrupt

The Sanitize Interrupt command has the following characteristics:

- The FFD receives the Sanitize Interrupt at any time.
- The Sanitize Interrupt initiates the immediate execution of the default Sanitize procedure.
- The default factory-preset Sanitize procedure is to erase the entire media and leave it empty (to perform the Security Erase option).
- If unit is powered up with Sanitize Interrupt active, the default Sanitize procedure is launched immediately.
- If the Sanitize Interrupt is still active upon completion of the default Sanitize procedure, the FFD restarts the default Sanitize procedure. This cycle is repeated indefinitely for as long as the Sanitize Interrupt command is active.

Note: Please contact the M-Systems sales offices for information regarding the available hardware Sanitize Interrupt options.

4.4.1.4 Auto-Resume Sanitize Feature

When Auto-Resume is enabled (the factory default setting), if a power interruption occurs during a Sanitize procedure the FDD restarts the Sanitize procedure on the next power-up.

If the Sanitize Interrupt command is active during power-up, the unit first completes the Sanitize procedure that was initiated before the power interruption. If the Sanitize Interrupt command is

still active when the procedure is complete, the FFD re-launches the default Sanitize procedure, as described in Table 10.

4.4.1.5 Random Data Written During the Sanitize Procedure

The random data used to overwrite user data is a digest of pseudo-random generation and real random data. The pseudo-random generation is seeded in such a manner that even if the FFD launches the Sanitize command under identical external conditions (for example, if the unit is powered on with Sanitize Interrupt active), it will produce different seeds and different pseudo-random data.

4.4.1.6 LED Activity During the Sanitize Procedure

During the Format and Sanitize procedures, the red LED provides the following indications:

a. Remains lit during the Erase phase (for the Sanitize procedure, during each erase phase)

b. Blinks during the Media Fill phase (for the Sanitize procedure, during each fill phase)

c. Remains lit for a short period while the disk achieves ready status after completing the Sanitize procedures.

4.4.1.7 Using the FFD After a Sanitize Procedure

After performing Sanitize Procedure, if fill option is not activated, the user must perform a low-level format on the media. Failing to perform the low-level format may result in a longer start-up time.

4.4.1.8 Sanitizing Based on DoD 5220.22-M

The USA DoD 5220.22-M National Industrial Security Program Operating Manual (NISPOM), January 1995, specifies the sanitization processes for each media type (in order to be considered declassified) in Chapter 8, Automated Information System Security. For Flash EPROM media type, the sanitize process is as follows:

- “Overwrite all addressable location with a single character.”
  Then
- “Perform a full chip erase as per manufacturer’s data sheet.”

The FFD complies with the above requirement, as described in Table 10.

4.4.1.9 Sanitizing Based on NSA Manual 130-2

The USA National Security Agency (NSA) specifies the procedure for sanitizing semiconductor memory devices in its 130-2 Media Declassification and Destruction Manual (Paragraph 5, Section 7). In the updated document version dated November 2000 Section 4.6c indicates the procedure for sanitizing EEPROM:

- “Overwriting all locations with a pseudo-random pattern twice”.
  Then
- “Overwriting all locations with a known pattern”.

The FFD complies with the above requirement, as described in Table 10.

4.4.1.10 Sanitizing Based on USA Air Force AFSSI 5020

The USA Air Force System Security Instruction (AFSSI) 5020, dated 20 August, 1996, specifies the procedure for sanitizing confidential media. Chapter 5, Semiconductor Devices, describes the security procedure for all types of semiconductor media. In Paragraph 5.3, the procedure for sanitizing flash memory is described as follows:

- "Pulsing the erase control gate and verifying the erasure".

  Then

- "Overwrite all bit locations with arbitrary unclassified data".

The FFD complies with the above requirement, as described in Table 10.

4.4.1.11 Sanitizing (Purging) Based on USA Army Regulation 380-19

The USA Army Regulation 380-19, Information Systems Security (ISS), effective 27 March, 1998, provides the security requirements for systems processing Special Access Program (SAP) information and describes the ISS policy as it applies to security in hardware, software procedures, telecommunication, personal use, physical environment, networks and firmware. Section VII, Automated Information System Media, Section 2-20, describes cleaning, purging, declassifying and destroying media. Appendix F-2 describes the following for sanitizing flash EPROM (FEPROM):

- "Overwrite all location with a random character, a specific character, then its complement"

  Then

- "Check with the DAA (Designated Approval Authority)/SCO (Service Certifying Organization) to see if additional procedures are required".

The FFD complies with the above requirement, as described in Table 10.

4.4.1.12 Sanitizing (Purging) Based on USA Navy NAVSO P-5239-26

The Navy Staff Office Publication (NAVSO) 5239, "Information Systems Security (INFOSEC) Program Guidelines" is issued by the Naval Information Systems Management Center and provides policy, guidelines, and procedures for clearing and purging computer system memory and other storage media for release outside of and for reuse within controlled environments. It pertains to both classified and sensitive unclassified information. Implements DOD 5200.28-M and CSC-STD-005-85. Chapter 3 describes the cleaning and purging of data storage media, and section 3.5 describes the purging of EEPROM and EAROM. To purge EEPROM:

- "Overwrite all location with any pattern," then erase.

The FFD complies with the above requirement, as described in Table 10.

4.4.1.13 Declassification Based on IRIG-106 (NTISSP-9)

The Telemetry Group (TG) of the Range Commanders Council (RCC) has prepared documents to foster the compatibility of telemetry transmitting, receiving, and signal processing equipment at the member ranges under the cognizance of the RCC.

IRIG (Inter-Range Instrumentation Group) 106 are set of Telemetry standards which provide the necessary criteria on which to base equipment design and modification.

The National Telecommunication & Information Security Systems (NTISSP-9) Chapter 10 describes the requirements for SOLID STATE RECORDER STANDARD. Section 10.8 (declassification) addresses declassification for various Solid-State Disks as follows:

- First Erase – Every memory block on the board is erased
- First write 0x55 – Every memory chip location is recorded with a pattern 0x55
- Second Erase – Every memory block on the board is erased
- Second write 0xAA – Every memory chip location is recorded with a pattern 0xAA
- Third Erase – Every memory block on the board is erased

M-Systems' FFD Sanitize feature complies with the above requirements as described in Table 10.

IRIGS-106 Usage

After initiating the Sanitize procedure with bad-block management according to IRIG-106, the number of blocks that failed to erase is returned in the registers of the FFD, as defined in Table 11.

Table 11: IRIG-106 Return Results

Register	7	6	5	4	3	2	1	0
Error	0							
Sector Count	Na							
Sector Number	0							
Cylinder Low	1 (number of sectors to be transferred)							
Cylinder High	0x80 (data transfer is from the device to host)							
Device/Head	NA	NA	NA	DEV	0			
Status	BSY	DRDY	DF	NA	DRQ	NA	NA	ERR

The number of blocks that failed to erase is returned in 1 sector of data.

Table 12: Sector of Data

	7	6	5	4	3	2	1	0
Byte 0	The number of blocks that failed to erase							
Byte 1	0							
Byte 2	0							
Byte 3	0							
…..	0							
Byte 511	0							

IRIG-106 READ FAILED SANITIZE BLOCKS LIST Command

The IRIG-106 READ FAILED SANITIZE BLOCKS LIST Command is a PIO DATA IN command. The data transfer is done in single sectors.

This command is used to retrieve the list of all the blocks in the media that failed to pass the sanitize process.

Table 13: IRIG-106 READ FAILED SANITIZE BLOCKS LIST Bit Description

Register	7	6	5	4	3	2	1	0
Features	0x07							
Sector Count	Max sector count							
Sector Number	Na							
Cylinder Low	'V'							
Cylinder High	'S'							
Device/Head	Partition mask				D	1		1
Command	81h							

The Max Sector Count register indicates the host allocated buffer size, in sectors. The device may not transfer data larger than the host allocated memory.

The returned data format is 4 bytes entry per block.

IRIG-106 READ FAILED SANITIZE BLOCKS DATA

Table 14: IRIG-106 READ FAILED SANITIZE BLOCKS DATA Bit Description

Register	7	6	5	4	3	2	1	0
Features	Secondary Operation Code							
Sector Count	Host Allocated buffer size							
Sector Number	0							
Cylinder Low	number of sectors to be transferred							
Cylinder High	0x80							
Device/Head	NA	NA	NA	DEV	0			
Command	83h							

There are five secondary operation codes:

- **0x00**: GET_DATA_LENGTH returns the size of block(s) that failed to erase in one sector of data.
- **0x01**: GET_FIRST_DATA sends the “failed to sanitize” data from the first block. The FFD aborts the command if the sanitize command with secondary operation code 0x22 has not been issued prior to the data retrieval request.
- **0x02**: GET_NEXT_DATA sends the next data in the pipeline. The FFD aborts the command if it reaches the end of the data, or if the sanitize command with secondary operation code 0x22 has not been issued prior to the data retrieval request.

- **0x03**: GET_BLOCK_DATA sends the data of the requested block. The FFD aborts the command if the sanitize command with secondary operation code 0x22 has not been issued prior to the data retrieval request.
- **0x04**: GET_BLOCK_NEXT_DATA sends the next data in the pipeline from a specific block. The FFD aborts the command if it reaches end of the data, or if the sanitize command with secondary operation code 0x22 has not been issued prior to the data retrieval request.

4.4.2. Security Erase Functionality

The Security Erase option enables quickly erasing all the data stored on the FFD. The FFD also supports the Quick Security Erase option, which is faster than the standard Security Erase option. This function is activated by the vendor-unique Sanitize command (see Section 4.4.1) or via the Sanitize hardware interrupt triggered by the Secure Erase header (if available). To enable activating the Quick Security Erase option, please contact your M-Systems technical representative.

Note: The time required to perform the security erase depends on the disk density and the type of flash components being used. Table 15 describes typical time required to complete the security erase for typical capacities.

ET – Erase Time; QET – Quick Erase Time

Table 15: Typical Erase Time (According to Disk Density)

Procedure	Security Erase	DoD 5220.22-M	NSA 130-2
Density (MB)	**Time to Erase Entire Media (sec)**	**Time to Erase + Char Fill + Erase (sec)**	**Time to Erase + Fill Random Char Twice + Erase + Fill Char (sec)**
4	6.0	252.8	556.8
8	12.0	483.2	1104.3
16	19.0	1725.6	4399.7
128	124.0	7341.8	17490.8

Note: The information in this section is relevant for FFD units with firmware version 1.03 and later.

Table 16: Typical Mount Time after Sanitize (According to Disk Density)

Density (GB)	Mount Time after Erase Entire Media (sec) Security Erase	DoD 5220.22-M Mount Time after Erase + Char Fill + Erase (sec)	NSA 130-2 (Erase + Fill Random Twice, Erase + Fill Char)
4	1.7	1.7	1.7
8	1.7	1.7	1.7
16	1.9	1.9	1.9
128	7.7	7.7	7.7

Note: The information in this section is relevant for FFD units with firmware version 1.03 and later.

Table 17: Quick Erase Time (According to Disk Density)

Density (GB)	Time to Erase Entire Media (sec) Security Erase	DoD 5220.22-M Time to Erase + Char Fill + Erase (sec)	NSA 130-2 (Erase + Fill Random Twice, Erase + Fill Char)
4	6.0	221.0	1006.8
8	12.0	226.4	1035.3
16	19.0	236.9	1067.4
128	124.0	256.7	1196.2

Note: The information in this section is relevant for FFD units with firmware version 1.03 and later.

Table 18: Mount Time after Quick Sanitize (According to Disk Density)

Density (GB)	Mount Time after Erase Entire Media (sec) Security Erase	DoD 5220.22-M Mount Time after Erase + Char Fill + Erase (sec)	NSA 130-2 (Erase + Fill Random Twice, Erase + Fill Char)
4	3.8	3.8	3.8
8	7.6	7.6	7.6
16	30.9	30.9	30.9
128	124.5	124.5	124.5

Typical power consumption during security erase depends on both the device density and on the NAND flash type. Note: The information in this section is relevant for FFD units with firmware version 1.03 and later.

Table 19 describes the specifications for Security Erase operations. The FFD input voltage is +5VDC, with a tolerance of 5% (4.75V-5.25V) and maximum ripple of 250 mV peak-to-peak.

Note: The information in this section is relevant for FFD units with firmware version 1.03 and later.

Table 19: Typical Power Consumption During Security Erase

Disk Density	Power Consumption During Security Erase		Power Consumption During Quick Security Erase	
GB	**mA**	**W**	**mA**	**W**
1-16	430	2.15	405	2.0
128	1400	7.0	1470	7.35

Note: The information in this section is relevant for FFD units with firmware version 1.03 and later.

4.4.3. Configuration

4.4.3.1 Configurable Parameters

The following parameter can be configured:

Sanitize Partition Information for four partitions. Each partition is defined as pair of numbers, <Start Sector> and <Partition Length in Sectors>.

4.4.3.2 Setting the Configurable Parameters

The structure of the SET PARAMETERS command is described in Table 20.

Table 20: Vendor-Specific Set Parameters Command

Register	7	6	5	4	3	2	1	0
Features	0xF0							
Sector Count	0							
Sector Number	0							
Cylinder Low	0							
Cylinder High	0							
Device/Head	0				D	1		1
Command	B0h							

The command transfers one sector of data with configurable parameters to the FFD. The format of the data is described in Table 21.

Table 21: Data Format on the FFD 2.5" Serial ATA

Word 0	Signature: 0x4E56
Word 1	Version: 0x100
Word 2	Reserved
Word 3	Number of Parameters in whole command
Word 4	Parameter 1 ID, MSB
Word 5	Parameter 1 ID, LSB
Word 6	Parameter 1 Value, MSB
Word 7	Parameter 1 Value, LSB
Word 8	...
	...
Word 251	
Word 252	Parameter 63 ID, MSB
Word 253	Parameter 63 ID, LSB
Word 254	Parameter 63 Value, MSB
Word 255	Parameter 63 Value, LSB

Each parameter ID is a 32-bit number. Each parameter value is also a 32-bit number. The following parameter IDs are currently defined:

Partition 0 Start Sector 0x10000

Partition 0 Length in Sectors 0x10001

Partition 1 Start Sector 0x10002

Partition 1 Length in Sectors 0x10003

Partition 2 Start Sector 0x10004

Partition 2 Length in Sectors 0x10005

Partition 3 Start Sector 0x10006

Partition 3 Length in Sectors 0x10007

The SET PARAMETERS command is aborted if an invalid Parameter ID or Parameter ID value is given, for example, if the partition size exceeds the media density.

4.4.3.3 Retrieving the Configurable Parameters

The structure of the GET PARAMETERS command is described in Table 22.

Table 22: Vendor-Specific Get Parameters Command

Register	7	6	5	4	3	2	1	0
Features	0xEF							
Sector Count	Parameter ID bits 0-7 (LSB)							
Sector Number	Parameter ID bits 8-15							
Cylinder Low	Parameter ID bits 16-23							
Cylinder High	Parameter ID bits 24-31 (MSB)							
Device/Head	0				D	1		1
Command	B0h							

The command transfers one sector of data with configurable parameters from the FFD, in the format described in Table 21 on page 29. If the parameter ID specified in the command registers is one of those listed in Section 4.4.3.2, the returned sector contains the value of that single ID. In addition, a group-ID is defined as:

All Partition IDs 0x1FFFF

In response to a group-ID given in the command registers, the returned sector will contain a list of parameter IDs from that group, and all their respective values.

4.4.4. Sanitizing Partitions

The FFD can be subdivided into a maximum of four partitions. When configuring your system for a Sanitize procedure, the following must be taken into account:

- A partition may be as small as one sector, or occupy the entire media.
- When a partition has a length of 0, if it is included in the partition mask it will have no effect on the Sanitize procedure.
- Partition values are always defined. The factory default is all partitions having length 0, i.e. nothing is erased if you use Sanitize with a partition mask value other than 0 without setting some new partition boundaries.
- Sanitizing all four partitions is not necessarily the same as sanitizing the whole media; it depends on the configuration of the partitions (starting block and length of each).
- Partitions may overlap in any fashion. Their combined set of sectors will be sanitized.
- You can define the default Sanitize procedure to have any partition mask.

4.4.5. S.M.A.R.T Command

In an effort to help users to avoid data loss, mechanical disk manufacturers incorporate logic into their drives that acts as an early warning system. This system is called Self-Monitoring Analysis and Reporting Technology, or S.M.A.R.T. The hard disk's integrated controller works with sensors to monitor various aspects of the drive's performance, and determines from this information whether or not the drive is behaving normally and reports its status. The fundamental principle behind S.M.A.R.T. is that many problems within mechanical hard disks do not occur suddenly, but result from a slow degradation of various mechanical components. Mechanical characteristics commonly analyzed by the S.M.A.R.T. command are head-flying height, number of remapped sectors, spin-up time, drive temperature and data throughput.

S.M.A.R.T implementation in the FFD takes an alternate approach. As the FFD is a solid-state disk with no moving parts, there is no point in testing FFD mechanical functionality. The S.M.A.R.T. command in the FFD analyzes the number of bad blocks that were accumulated in the FFD relative to the total amount of spare blocks.

When the flash media returns a failure at a block, the data from that block is transferred to a spare block (transparently to the host), and the failed block is marked as bad. The number of spare blocks on the media is close to 4%, which provides balance between cost and reliability.

When the S.M.A.R.T. command is executed, subcommand is RETURN STATUS and the FFD calculates the following parameters:

- The total number of spare blocks reserved at the time the FFD was shipped from the factory.
- The current number of spare blocks available on the FFD.

For the S.M.A.R.T. command, the subcommand RETURN STATUS returns one of two possible statuses:

- **Passed**: If less than 95% of the total reserved spare blocks at the time of shipment were already used.
- **Failed**: If more than 95% of the total reserved spare blocks at the time of shipment were already used

The S.M.A.R.T remote monitoring analysis can be used as a trigger for disk alarm and for immediate preventative maintenance, namely to replace the FFD before it passes into read-only mode.

4.4.6. Format Unit Command

The drive is shipped from the factory low-level formatted and ready for use. In order to initiate a low-level format, the initiator must issue a low-level format command (opcode F7h).

The Format Unit command performs low-level formatting on the FFD.

Table 23: Format Unit Command

Register	7	6	5	4	3	2	1	0
Features								
Sector Count								
Sector Number								
Cylinder Low								
Cylinder High								
Device/Head					D	1		1
Command	F7h							

5. FIRMWARE UPGRADE

The FFD is a firmware upgradeable disk.

6. MOUNT TIME

The total time required to mount the FFD, described in Table 24, depends on the device density.

Table 24: Mount Time (According to Density, After Low-Level Format)

Density (GB)	Duration (sec)
4	1.7
8	1.7
16	1.9
128	7.7

Note: The information in this section is relevant for FFD units with firmware version 1.04 and later.

7. COMPATIBILITY

The FFD is guaranteed to comply with the following requirements:

CE, UL, EN 55022 Class B, CISPR 22 Class B, AS/NZS 3548 Class B, BSMI CNS 13438 Class B, CAN/CSA-V-3/2001.04 (VCCI), FCC Part 15 Class B, EN 61000-3-2, EN 61000-3-3, IEC 61000-4-2/3/4/5/6/8/11.

8. LABEL INFORMATION

The bottom cover label contains the following information:

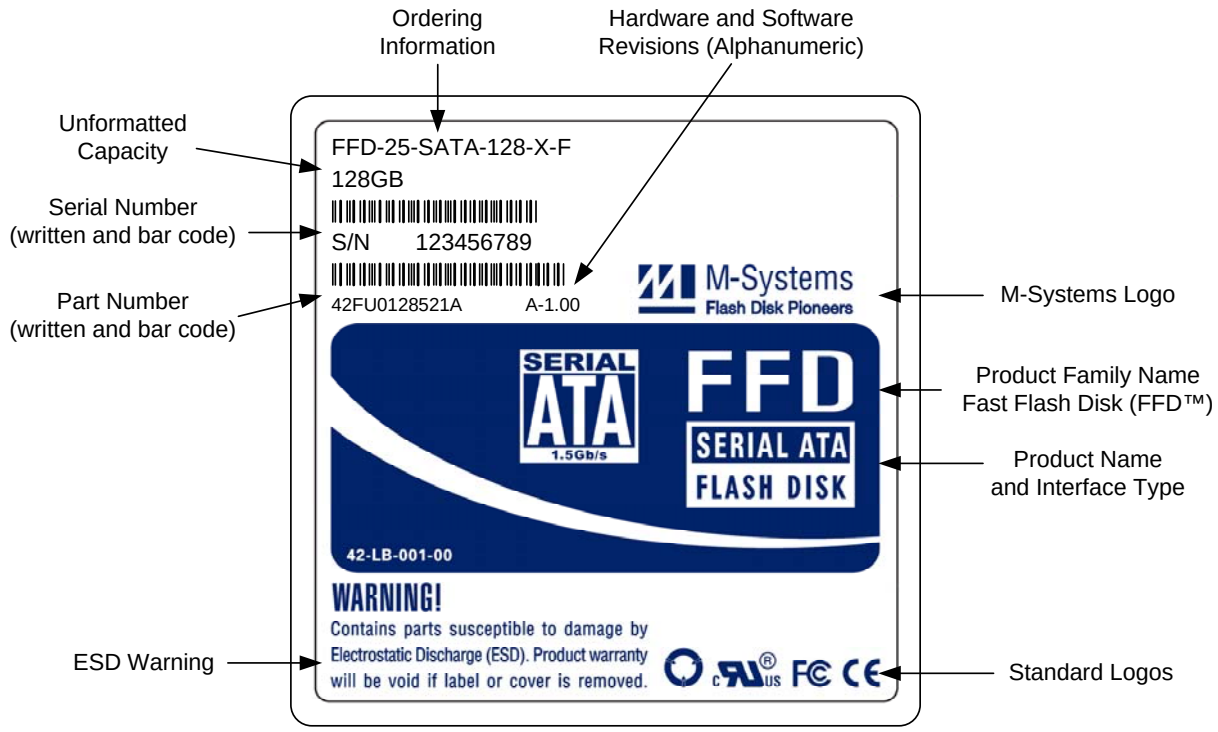


Figure 6: FFD 2.5" Serial ATA Label

9. BUILT-IN TEST (BIT)

The FFD performs a power-up test to ensure that its basic components are functioning. Upon power-up the following is tested:

- RAM
- Boot flash
- Interface controller
- Timers
- DMA controller
- Flash media

10. INSTALLING AND USING THE FFD 2.5” SERIAL ATA

This section provides you with the information you need to properly install your new FFD 2.5” Serial ATA Flash Disk. M-Systems recommends that qualified and trained personnel install the drive.

The following chapters contain handling information, mounting considerations, address and configuration setups, cabling and connector information and information about obtaining technical assistance and service.

Remember - Always back up your data before adding disk drives to your system!

10.1. Kit Contents

Ensure that your kit contains the following items:

- FFD 2.5” Serial ATA Flash Disk
- Four mounting screws and three jumpers, M-Systems part no. 41-PK-001-00.

If any items are missing, please contact your dealer.

10.2. Visual Inspection

Before unpacking or handling a drive, take all proper electrostatic discharge (ESD) precautions, including personnel and equipment grounding.

Before you begin installing the FFD, inspect the package and device as follows:

- If the shipping container appears to be damaged or water stained, notify your dealer.
- Remove the disk from its shipping enclosure and inspect it for any damage that may have occurred during shipment. If any damage is observed, notify your dealer.
- Record the disk serial number and shipment date.
- Retain the original shipping enclosure and all packing material for re-shipment.

10.3. Handling Instructions

You can prolong the life of your FFD, increase its reliability, and prevent unnecessary damage by following the instructions listed below. Failure to follow any of these instructions may void your warranty.

- Always take all proper electrostatic discharge (ESD) precautions, including personnel and equipment grounding.
- Always operate the FFD within the environmental specifications.
- Always use a grounded wrist strap when handling the FFD. Drives that are not installed in the system are sensitive to ESD damage.
- Always handle the FFD carefully.

- Never switch DC power to the drive by plugging an electrically live source cable into the drive's power connector.
- Pay attention to the cable polarity whenever connecting the drive to the cable.

10.4. Installation

10.4.1. System Requirements

In order to install the FFD in your system, ensure that you have the following items:

- System mounting hardware
- The cable size may be 30 to 26 AWG. The cable maximum length should be one meter.

10.4.2. FFD Configuration

10.4.3. Installation

The FFD can be installed in the system in any mounting position. Unlike rotating disks that have an axis of rotation, the FFD is not susceptible to damage due to its orientation.

Note: It is not necessary to perform a low-level format on the FFD. The drive is shipped low-level formatted and ready for use.

10.4.3.1 Installing the FFD in a PC Environment

To install the FFD:

1. Power down the PC and remove the cover.
2. Mount the FFD in a free drive bay.
3. Connect a cable between the FFD and the host.
4. Close the PC cover and power on the PC.
5. The host BIOS sign-on message will appear and display a key sequence to enter the BIOS setup. Set up the BIOS to recognize the FFD (refer to the BIOS documentation for the disk installation procedure).

You are now ready to use the FFD. If you encounter any problems, refer to Section 11 for troubleshooting information.

10.4.3.2 Using the FFD in an MS-DOS-Based Platform

After installing the FFD (as described in Section 10.4.3), it must be installed as a disk drive under DOS. Run the DOS commands listed below and follow the instructions displayed for each command. For more information regarding the DOS commands, refer to your DOS manual.

1. Run the DOS FDISK program to partition the FFD.
2. Verify that the partition is active and ready for formatting.
3. Run the DOS FORMAT command to high-level format the FFD.

4. If you want the FFD to be a bootable drive, run the DOS SYS command and change its partition to active.

10.4.3.3 Using the FFD in a Windows-Based Platform

The FFD requires no special adjustments or modifications, and can be used just like a magnetic hard drive.

10.4.3.4 Using the FFD in a Linux-Based Platform

The FFD requires no special adjustments or modifications, and can be used just like a magnetic hard drive.

10.4.3.5 Using the FFD in Other OS/Platforms

The FFD requires no special adjustments or modifications, and can be used just like a magnetic hard drive.

11. TROUBLESHOOTING

11.1. The FFD Is Not Identified by the System BIOS

11.1.1. Basic Checks

Most disk problems are caused by improper disk installation. First, check the following:

- Cable problems:
  - Cable length exceeds the limit specified in the standard
  - Low quality cable
- Power supply is below FFD requirements

11.1.2. BIOS Setup

Verify that the disk is enabled in the BIOS. In most new BIOSs, there is an option to allow auto identification of the drive. This usually works.

11.2. Disk Performance Is Slow

If you are experiencing poor disk performance, it may be due to one of the following reasons:

- The FFD is operating only with ultra DMA modes 0-2.
- The FFD is operating in PIO mode under Windows.
- DMA transfer mode may not be enabled in the Windows OS settings. Windows has a fallback mechanism that causes the disk operating mode to revert to PIO if too many errors occur.

11.3. The FFD Functions as an Additional Drive but Fails to Boot

If the FFD fails to boot even though the OS recognizes it as an additional drive, check the following:

- Verify that the partition on the drive is active. Some partitioning utilities, such as DOS FDISK, automatically set a partition to active when the FFD is the only disk in the system. If other disk with an active partition is present in the system, the FDISK utility does not allow setting additional partitions as active.
- Verify that the operating system is properly installed.

11.4. Linux Installation Is Complete but the System Does Not Boot

Verify that the partitions are large enough. When using a small-density drive, an older installation CD may fail to properly divide the disk into partitions.

This bug has been fixed in newer installation utilities. If you use your own customized Linux, verify that you have the latest kernel as a base for your modified version.

12. ORDERING INFORMATION

Table 25: Ordering Information for the FFD 2.5" Serial ATA

FFD-25-SATA-CCC-T-H-P		
CCC:	Unformatted density (GB)	1, 2, 4, 8, 16, 24, 32, 40, 48, 56, 64, 72, 80, 88, 96, 104, 112, 120, 128
T:	Temperature range	Blank: Commercial 0°C - +70°C N: Enhanced -25°C - +75°C X: Extended -40°C - +85°C
H:	Case height	A – 9.5 mm up to 16GB B – 14.5 mm up to 64GB C – 18.5 mm up to 112GB D – 22.5 mm up to 128GB
P:	RoHS support	Blank: Non-RoHS version P: RoHS version

Note: The information in this section is relevant for FFD units with firmware version 1.03 and later.

HOW TO CONTACT US

USA

M-Systems, Inc.
555 North Mathilda Avenue
Suite 220
Sunnyvale, CA 94085
Tel: +1-408-470-4440
Fax: +1-408-470-4470

China

M-Systems Flash Disk Pioneers (Shenzhen) Trading Ltd.
Room 121-122
Bldg. 2, International Trade & Commerce Bldg.
1001 HongHus Rd.
Futian Free Trade Zone
Shenzhen, China
Tel: +86-755-8348-5218
Fax: +86-755-8348-5418

Japan

M-Systems Flash Disk Pioneers Japan, Inc.
Asahi Seimei Gotanda Bldg., 3F
5-25-16 Higashi-Gotanda
Shinagawa-ku Tokyo, 141-0022
Tel: +81-3-5423-8101
Fax: +81-3-5423-8102

Korea

M-Systems Asia Ltd. Korea Representative Office
#1002 BYC Building
648-1 Yeoksam-dong
Kangnam-ku, Seoul, Korea
Tel: +82-2-3452-9079
Fax: +82-2-3452-9145

Taiwan

M-Systems Asia, Ltd.
Room 14F
No. 6, Sec. 3
Minquan East Rd
Zhongshan District
Taipei, Taiwan, 104
Tel: +886-2-2515-2522
Fax: +886-2-2515-2295

Europe

M-Systems Flash Disk Pioneers Ltd.
7 Atir Yeda St.
Kfar Saba 44425, Israel
Tel: +972-9-764-5000
Fax: +972-3-548-8666

Internet

www.m-systems.com

Information

info@m-systems.com

This document is for information use only and is subject to change without prior notice. M-Systems Flash Disk Pioneers Ltd. assumes no responsibility for any errors that may appear in this document. No part of this document may be reproduced, transmitted, transcribed, stored in a retrievable manner or translated into any language or computer language, in any form or by any means, electronic, mechanical, magnetic, optical, chemical, manual or otherwise, without prior written consent of M-Systems.

M-Systems products are not warranted to operate without failure. Accordingly, in any use of the Product in life support systems or other applications where failure could cause injury or loss of life, the Product should only be incorporated in systems designed with appropriate and sufficient redundancy or backup features.

Contact your local M-Systems sales office or distributor, or visit our website at www.m-systems.com to obtain the latest specifications before placing your order.

© 2006 M-Systems Flash Disk Pioneers Ltd. All rights reserved.

M-Systems, DiskOnChip, DiskOnKey, DiskOnKey MyKey, FFD, Fly-By, iDiskOnChip, iDOC, mDiskOnChip, mDOC, MegaSIM, SuperMAP, TrueFFS, uDiskOnChip, uDOC, and Xkey are trademarks or registered trademarks of M-Systems Flash Disk Pioneers, Ltd. Other product names or service marks mentioned herein may be trademarks or registered trademarks of their respective owners and are hereby acknowledged. All specifications are subject to change without prior notice.